

- 1 1. In the field of audio communication, a steganographic method for embedding
2 data, comprising the steps of:
3 a first step of inputting a digital host audio signal;
4 dividing said host audio signal into non-overlapping frames;
5 computing the frame power f_e ;
6 a second step of inputting a digital signal to be embedded;
7 determining whether a "0" is to be embedded;
8 IF a "0" is to be embedded; THEN
9 setting the power of a tone at f_0 to a percentage of the power of f_e ;
10 setting the power of a tone at f_1 to a fraction of the power of said
11 tone at f_0 ;
12 embedding said tone at f_0 and said tone at f_1 into said frame of said
13 host audio signal;
14 transmitting said frame of said host audio signal;
15 inputting next frame of said host audio signal and next bit of said
16 digital signal to be embedded; and
17 returning to said step of determining;
18 OTHERWISE;
19 setting the power of a tone at f_1 to a percentage of the power of f_e ;
20 setting the power of a tone at f_0 to a fraction of the power of said
21 tone at f_1 ; and
22 returning to said step of embedding.
23
24
- 1 2. Method of claim 1, further comprising a steganographic method for recovering
2 embedded data, comprising the steps of:
3 receiving a digital audio signal containing an embedded digital signal;
4 dividing said received audio signal into non-overlapping frames;
5 computing the frame power f_e of each said non-overlapping frame of said
6 received digital host audio signal;

7 determining whether $(f_e / f_0) > (f_e / f_1)$
 8 IF $(f_e / f_0) > (f_e / f_1)$, THEN
 9 declaring the embedded bit to be a "0"; and
 10 returning to said step of computing said frame power for the next
 11 frame of said received digital host audio signal;
 12 OTHERWISE,
 13 declaring the embedded bit to be a "1"; and
 14 returning to said step of computing said frame power for the next
 15 frame of said received digital host audio signal.

16

1 3. Method of claim 1, wherein said non-overlapping frames are 16 milliseconds in
 2 length.

3

1 4. Method of claim 2, wherein said non-overlapping frames are 16 milliseconds in
 2 length.

3

1 5. Method of claim 1, wherein
 2 said power of said tone at f_0 is 0.25% the power of f_e ; and
 3 said power of said tone at f_1 is 0.001 of the power of said tone at f_0
 4 whenever a "0" is to be embedded.

5

1 6. Method of claim 1, wherein
 2 said power of said tone at f_1 is 0.25% the power of f_e ; and
 3 said power of said tone at f_0 is 0.001 of the power of said tone at f_0
 4 whenever a "1" is to be embedded.

5

1 7. In the field of audio communication, a steganographic method for embedding two
 2 bits of data, comprising the steps of:
 3 a first step of inputting a digital host audio signal;
 4 dividing said host audio signal into non-overlapping frames;
 5 computing the frame power f_e ;

6 a second step of inputting a digital signal to be embedded;
 7 a first step of determining whether a "00" is to be embedded;
 8 IF a "00" is to be embedded; THEN
 9 setting the power of a tone at f_0 to a percentage of the power of f_e ;
 10 setting the power of tones at f_1 , f_2 and f_3 to a fraction of the power of said tone
 11 at f_0 ;
 12 embedding said tone at f_0 and said tones at f_1 , f_2 and f_3 into said frame of said
 13 host audio signal;
 14 transmitting said frame of said host audio signal;
 15 inputting next frame of said host audio signal and next two bits of said digital
 16 signal to be embedded; and
 17 returning to said first step of determining;
 18 OTHERWISE;
 19 a second step of determining whether a "01" is to be embedded;
 20 IF a "01" is to be embedded; THEN
 21 setting the power of a tone at f_1 to a percentage of the power of f_e ;
 22 setting the power of tones at f_0 , f_2 and f_3 to a fraction of the power of said
 23 tone at f_1 ;
 24 embedding said tone at f_1 and said tones at f_0 , f_2 and f_3 into said frame of
 25 said host audio signal;
 26 transmitting said frame of said host audio signal;
 27 inputting next frame of said host audio signal and next two bits of said
 28 digital signal to be embedded; and
 29 returning to said first step of determining;
 30 OTHERWISE;
 31 a third step of determining whether a "10" is to be embedded;
 32 IF a "10" is to be embedded; THEN
 33 setting the power of a tone at f_2 to a percentage of the power of f_e ;
 34 setting the power of tones at f_0 , f_1 and f_3 to a fraction of the power of
 35 said tone at f_2 ;

36 embedding said tone at f_2 and said tones at f_0 , f_1 and f_3 into said frame
 37 of said host audio signal;
 38 transmitting said frame of said host audio signal;
 39 inputting next frame of said host audio signal and next two bits of said
 40 digital signal to be embedded; and
 41 returning to said first step of determining;
 42 OTHERWISE;
 43 a fourth step of determining whether a "11" is to be embedded;
 44 IF a "11" is to be embedded; THEN
 45 setting the power of a tone at f_3 to a percentage of the power of f_e ;
 46 setting the power of tones at f_0 , f_1 and f_2 to a fraction of the power of
 47 said tone at f_3 ;
 48 embedding said tone at f_3 and said tones at f_0 , f_1 and f_2 into said
 49 frame of said host audio signal;
 50 transmitting said frame of said host audio signal;
 51 inputting next frame of said host audio signal and next two bits of
 52 said digital signal to be embedded; and
 53 returning to said first step of determining.

54

1 8. Method of claim 7, further comprising a steganographic method for recovering
 2 embedded data, comprising the steps of:
 3 receiving a digital audio signal containing an embedded digital signal;
 4 dividing said received digital audio signal into non-overlapping frames;
 5 computing the frame power f_e and the frame power at f_0 , f_1 , f_2 and f_3 of each non-
 6 overlapping frame of said received digital audio signal;
 7 computing the ratios (f_e / f_0) , (f_e / f_1) , (f_e / f_2) and (f_e / f_3) ;
 8 a first step of determining whether (f_e / f_0) is the lowest ratio;
 9 IF (f_e / f_0) is the lowest ratio; THEN
 10 declaring the embedded bits to be "00"; and
 11 returning to said step of computing the frame power f_e and the frame power at
 12 f_0 , f_1 , f_2 and f_3 of next frame of said received digital host audio signal;

13 OTHERWISE;
14 a second step of determining whether (f_e / f_1) is the lowest ratio;
15 IF (f_e / f_1) is the lowest ratio; THEN
16 declaring the embedded bits to be "01"; and
17 returning to said step of computing the frame power f_e and the frame
18 power at f_0, f_1, f_2 and f_3 of next frame of said received digital host audio
19 signal;
20 OTHERWISE;
21 a third step of determining whether (f_e / f_2) is the lowest ratio;
22 IF (f_e / f_2) is the lowest ratio; THEN
23 declaring the embedded bits to be "10"; and
24 returning to said step of computing the frame power f_e and the
25 frame power at f_0, f_1, f_2 and f_3 of next frame of said received
26 digital host audio signal;
27 OTHERWISE;
28 a fourth step of determining whether (f_e / f_3) is the lowest ratio;
29 IF (f_e / f_3) is the lowest ratio; THEN
30 declaring the embedded bits to be "11"; and
31 returning to said step of computing the frame power f_e
32 and the frame power at f_0, f_1, f_2 and f_3 of next frame of
33 said received digital host audio signal.

34

1 9. Method of claim 7, wherein said non-overlapping frames are 16 milliseconds in
2 length.

3

1 10. Method of claim 8, wherein said non-overlapping frames are 16 milliseconds in
2 length.

3

1 11. Method of claim 7, wherein
2 said power of said tone at f_0 is 0.05% the power of f_e ; and
3 said power of said tones at f_1, f_2 and f_3 is 0.001 of the power of said tone at f_0

4 whenever a “00” is to be embedded.

5

1 12. Method of claim 7, wherein

2 said power of said tone at f_1 is 0.05% the power of f_c ; and

3 said power of said tones at f_0 , f_2 and f_3 is 0.001 of the power of said tone at f_1

4 whenever a “01” is to be embedded.

5

1 13. Method of claim 7, wherein

2 said power of said tone at f_2 is 0.05% the power of f_c ; and

3 said power of said tones at f_0 , f_1 and f_3 is 0.001 of the power of said tone at f_2

4 whenever a “10” is to be embedded.

5

1 14. Method of claim 7, wherein

2 said power of said tone at f_3 is 0.05% the power of f_c ; and

3 said power of said tones at f_0 , f_1 and f_2 is 0.001 of the power of said tone at f_2

4 whenever a “11” is to be embedded.